

Serial No.: 10/780,384

### **Remarks/Arguments**

Applicants respectfully request favorable reconsideration of the subject application, particularly in view of the above amendment and the following remarks. There is no additional fee for the amendment as the number of independent claims and the total number of claims pending in the application has been reduced.

Applicants have amended Claims 24-29 to indicate their status as having been withdrawn from the subject application. The withdrawal of Claims 24-29 is the result of an election made by Applicants in response to a requirement for restriction/election issued by the Examiner. The remaining claims remain unchanged.

The invention claimed by Applicants is an apparatus comprising a carbonaceous material reactor vessel having a carbonaceous material inlet, an hydrogen-rich gas outlet, a retentate gas outlet, a reaction zone containing a carbonaceous material, and a product gas zone containing reaction product gas, and at least one permeable hydrogen-selective membrane disposed *inside* the carbonaceous material reactor vessel and having a first side in contact with the reaction product gas and an opposite second side in contact with an hydrogen-rich gas. *The essential feature of this invention is the disposition of a membrane selective for hydrogen permeation inside a reactor vessel in which a carbonaceous material is converted to a reaction product gas (typically a synthesis gas) comprising hydrogen*

Serial No.: 10/780,384

as a result of which the generated hydrogen is able to be immediately separated from the other components comprising the reaction product gas. Applicants respectfully urge that the prior art relied upon by the Examiner for rejection of the subject application neither teaches nor suggests an apparatus as claimed by Applicants comprising *a membrane selective for hydrogen permeation disposed inside a carbonaceous material reactor vessel*.

Claims 1-12 and 14-23 have been rejected under 35 U.S.C. 102(b) as being anticipated by Wachsman et al., U.S. Patent 6,235,417 (hereinafter “the ‘417 Wachsman et al. patent”). This rejection is respectfully traversed. The ‘417 Wachsman et al. patent teaches a two-phase hydrogen permeation membrane utilizing the combination of a perovskite-type oxide and a palladium metal and a process for separating hydrogen from a hydrogen-containing gas by means of the membrane (Col. 1, lines 6-10). Fig. 1 of the ‘417 Wachsman et al. patent, which the Examiner relies upon as showing the elements of the apparatus of the invention claimed by Applicants, is described as “a schematic illustration of the hydrogen permeation according to the invention” disclosed therein (Col. 3, lines 56-57). Applicants note that the only other description of Fig. 1 in the ‘417 Wachsman et al. patent is set forth in Col. 4, lines 23-26 where it is stated

Serial No.: 10/780,384

“The corresponding conductivities are plotted in FIG. 1 and compared to AC impedance data for sintered disks of  $\text{BaCe}_{0.85}\text{Gd}_{0.15}\text{O}_3$  at elevated temperature.”

Applicants suggest that clearly the cited passage is not a description of Fig. 1 of the ‘417 Wachsman et al. patent.

Applicants are enclosing herewith a copy of U.S. Patent 6,296,687 B2, also Wachsman et al. (hereinafter “the ‘687 Wachsman et al. patent”), directed to the same subject matter as the subject matter of the ‘417 Wachsman et al. patent, including the same Fig. 1 as shown in the ‘417 Wachsman et al. patent. Col. 4, lines 3-13 of the ‘687 Wachsman et al. patent states

“Fig. 1 shows conceptually how  $\text{H}_2$  permeation takes place according to the invention. This shows a membrane reactor 10 in which the wall 11 may be either a  $\text{H}_2$  permeation membrane 12 or an electrode 13.

Natural gas or synthesis gas is fed through the reactor 10. The natural gas is converted to  $\text{H}_2$  and  $\text{C}_{2+}$ , with in situ  $\text{H}_2$  separation by way of the electrode 13 or  $\text{H}_2$  is separated from the syn gas by means of the  $\text{H}_2$  permeation membrane 12.”

The Examiner argues that Fig. 1 of the ‘417 Wachsman et al. patent shows a carbonaceous material reactor vessel having a carbonaceous material inlet (Feed), an hydrogen-rich gas outlet ( $\text{H}_2$ ), a retentate gas outlet (Higher value products), a reaction zone containing a carbonaceous material, a product gas zone containing

reaction product gas, and at least one permeable hydrogen-selective membrane disposed within the carbonaceous material reactor vessel. Applicants respectfully disagree with the Examiner's characterization of Fig. 1 of the '417 Wachsman et al. patent, particularly in view of the description of Fig. 1 set forth in the '687 Wachsman et al. patent.

According to the explicit teachings of the '687 Wachsman et al. patent, Fig. 1 shows a membrane reactor 10, which the Examiner has argued corresponds to a carbonaceous material reactor vessel as claimed by Applicants, having a wall 11 which may be an H<sub>2</sub> permeation membrane 12 or an electrode 13. In accordance with the cited text of the '687 Wachsman et al. patent, for the embodiment in which the wall 11 is a H<sub>2</sub> permeation membrane 12, H<sub>2</sub> is "separated from the syn gas" by means of the membrane. Since H<sub>2</sub> permeation membrane 12 corresponds to the wall 11 of the membrane reactor 10, Applicants respectfully urge that Fig. 1 and, thus, the '417 Wachsman et al. patent (or the '687 Wachsman et al. patent) *does not show* a permeable hydrogen-selective membrane disposed *within, i.e. inside*, a carbonaceous material reactor vessel as required by Applicants' claimed invention. That is, nowhere does the '417 Wachsman et al. patent teach or suggest disposition of the membrane reactor 10 *inside* a carbonaceous material reactor vessel, which Applicants respectfully urge, would be the only configuration by which H<sub>2</sub> permeation membrane

Serial No.: 10/780,384

12 could be considered to be disposed *within* a carbonaceous material reactor vessel as required by Applicants' claimed invention.

In addition, the Examiner further cites Col. 1, lines 13-20 of the '417 Wachsman et al. patent as teaching that the alleged carbonaceous material reactor vessel is a gasification reactor vessel as recited in Claim 2 of the subject application. Applicants respectfully urge that it is well known to those skilled in the art that a gasification reactor vessel is one in which a solid or liquid carbonaceous material or fuel is converted to a gaseous fuel, typically a synthesis gas. The fact that a vessel may be employed for the purpose of converting natural gas to hydrogen as described by the '417 Wachsman et al. patent does not mean that the vessel is a gasification vessel. Accordingly, Applicants respectfully urge that the '417 Wachsman et al. patent neither teaches nor suggests disposition of the membrane reactor disclosed therein within a gasification reactor as claimed by Applicants. Given that the '417 Wachsman et al. patent neither teaches nor suggests disposition of a permeable hydrogen-selective membrane within a carbonaceous material reactor vessel as required by Applicants' claimed invention, Applicants respectfully urge that the '417 Wachsman et al. patent does not anticipate the invention claimed by Applicants in the manner required by 35 U.S.C. 102(b).

Claim 17 of the subject application states

Serial No.: 10/780,384

“An apparatus in accordance with Claim 14, wherein said permeable hydrogen-selective membrane is operable at temperatures up to at least about 2000°C.”

The Examiner argues that the manner of operating an apparatus does not differentiate the apparatus from the prior art. Applicant respectfully urges that in the recited claim, no manner of operation as being recited. Rather, the claim is suggesting that the membrane is made of a material so as to be able to withstand operating temperatures up to at least 2000°C. Thus, membranes made of materials which are not able to withstand operating temperatures up to at least 2000°C would not be an element of the claimed apparatus. Applicants respectfully urge that no such membranes are taught or suggested by the ‘417 Wachsman et al. patent.

Claim 13 has been rejected under 35 U.S.C. 103(a) as being unpatentable over the ‘417 Wachsman et al. patent in view of Keskar et al., U.S. Patent 6,066,307 (hereinafter “the Keskar et al. patent”). This rejection is respectfully traversed. The Keskar et al. patent teaches a method of producing hydrogen using a solid electrolyte membrane in which a compressed and heated oxygen-containing gas mixture is passed into a reactor having at least one solid electrolyte oxygen ion transport membrane to separate transported oxygen in which reactor an organic fuel reacts with oxygen separated from the oxygen-containing gas to form synthesis gas. The resulting synthesis gas is separated into hydrogen gas through at least one solid

Serial No.: 10/780,384

electrolyte hydrogen transport membrane to separate the transported hydrogen in the same or different separator (Abstract). Citing Col. 2, lines 19-30, the Keskar et al. patent is relied upon by the Examiner as teaching that it is favorable to utilize a fluidized bed as a gasification reactor with a membrane reformer, based upon which the Examiner argues that it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the apparatus of the '417 Wachsman et al. patent with the teachings of the Keskar et al. patent to utilize a fluidized bed as such modification would result in improved rates of reaction for the production of gasification products.

Applicants' arguments with respect to the '417 Wachsman et al. patent as set forth herein above are equally applicable to this rejection and, thus, will not be repeated other than to reiterate that the '417 Wachsman et al. patent neither teaches nor suggests disposition of a permeable hydrogen-selective membrane within a carbonaceous material reactor vessel as required by Applicants' claimed invention.

Col. 2, lines 19-21 states

“To improve the rates of reactions and selectivity of certain products, an *external* catalyst in the form of a fixed or fluidized bed, or a plurality of catalyst tubes, may be used.” (emphasis added)

Applicants respectfully urge that the passage of the Keskar et al. patent cited by the Examiner *does not teach the use of a fluidized bed as a gasification reactor with a*

Serial No.: 10/780,384

*membrane reformer*. Rather, the cited passage merely teaches that it is known to use an external catalyst in the form of a fixed or fluidized bed to promote the reactions of partial oxidation and/or steam reforming of hydrocarbon feedstocks. Nowhere does the passage indicate use of a gasification reactor with a membrane reformer. In addition, because the '417 Wachsman et al. patent does not teach or suggest disposition of a permeable hydrogen-selective membrane within a carbonaceous material reactor vessel as required by Applicants' claimed invention, Applicants respectfully urge that the combination of the teachings of the '417 Wachsman et al. patent and the Keskar et al. patent would not result in the invention claimed by Applicants, i.e. disposition of a permeable hydrogen-selective membrane within, i.e. inside, a fluidized bed gasification reactor as claimed by Applicants. Accordingly, Applicants respectfully urge that the '417 Wachsman et al. patent and the Keskar et al. patent, alone or in combination, do not render Applicants' claimed invention obvious in the manner required by 35 U.S.C. 103(a).

### **Conclusion**

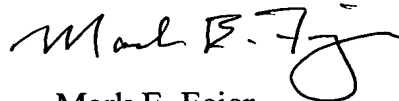
Applicants intend to be fully responsive to the outstanding Office Action. If the Examiner detects any issue which the Examiner believes Applicants have not addressed in this response, Applicants urge the Examiner to contact the undersigned.



Serial No.: 10/780,384

Applicants sincerely believe that this patent application is now in condition for allowance and, thus, respectfully request early allowance.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Mark E. Fejer", with a stylized flourish at the end.

Mark E. Fejer  
Regis. No. 34,817

Gas Technology Institute  
1700 South Mount Prospect Road  
Des Plaines, Illinois 60018  
TEL (847) 768-0832; FAX (847) 768-0802